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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk



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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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If no title is shown please refer to the description.
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Heating closely spaced pipe ends before forge welding

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HEATING CLOSELY SPACED PIPE ENDS BEFORE FORGE WELDING

Background of the invention

The invention relates to method for heating closely spaced pipe ends before they are joined together by forge welding.

5 Forge welding involves circumferential heating of the pipe ends that are to be joined and subsequently pressing the pipe ends together to form a metallurgical bond .

 A large variety of heating technologies may be used to make the pipe ends hot enough such that the
10 metallurgical bond can be made. The heating techniques may involve electric, electromagnetic, induction, infrared, sparking and/or friction heating or combinations of these and other heating methods.

 When used in this specification the term forge
15 welding is intended to encompass all techniques which involve circumferential heating of pipe ends and subsequent metallurgical bonding the heated pipe ends, including welding techniques that are generally known as (dif-)fusion welding, friction welding, flash welding
20 and/or butt welding.

 It is known from US patents 4,566,625 ; 4,736,084 ; 4,669,650 and 5,721,413 issued to Per H. Moe that it may be beneficial to flush the pipe ends just before and during the forge welding operation with a reducing
25 flushing gas, such as hydrogen or carbon monoxide, such that any oxygen skin is removed from the heated pipe ends and a metallurgical bond with a minimal amount of irregularities is obtained. It is also known

from US patents 2,719,207 and 4,728,760 to use non explosive mixtures comprising about 95% by volume of a substantially inert gas, such as argon, nitrogen and/or helium, and about 5% by volume of a reducing gas, such as hydrogen and/or carbon monoxide for flash welding and induction butt welding.

Experiments have shown that forge welding techniques are capable to generate high quality metallurgical bonds between the tubular end, in particular if the pipe end are flushed with a reducing flush gas mixture during the welding operation and if the pipe ends are heated quickly and uniformly.

In order to quickly and uniformly heat the pipe ends it is generally desirable to maintain the pipe ends close to each other during the heat up phase.

US patent 5,721,413 discloses that if the pipe ends are heated by a high frequency electrical heating a proximity effect is created which keeps the current density, and thus the heating rate, strong in the region of the heated end faces. Thus it is desired to limit the spacing between the pipe ends during the heat up phase to less than only a few millimeters. However, it may be difficult to preserve such close spacing between the pipe ends if the pipe ends are welded together away from a well controllable manufacturing sites, such as on a drilling rig, offshore platform or pipelaying barge, which may itself move and or vibrate during a storm or in a rough sea.

An object of the present invention is to provide a method to preserve a well defined spacing between the ends of tubular that are heated just before a forge welding operation, also if the pipes are welded on a vibrating and/or moving rig or pipelaying vessel and also

if the pipes are wet and/or greasy such that the grips which hold the pipes would slip along the pipe surfaces.

Summary of the Invention

5 In accordance with the present invention there is provided a method for maintaining a predetermined spacing between pipe ends during a heat up phase before a forge welding operation, the method comprising inserting a plurality of heat resistant spacing elements of a substantially equal thickness between the pipe ends,
10 pressing the pipe ends against the spacing elements during the heat up phase and removing the spacing elements from the spacing before the pipe ends are pressed together to join them by forge welding.

If the pipe ends are heated by electrodes which
15 transmit a high frequency current through the pipe wall to heat the pipe ends and then it is desired that the spacing elements each have a thickness less than 5 millimeters. Preferably, an assembly of three or more spacing elements is inserted between the pipe ends,
20 which spacers each have a thickness less than 2 millimeters.

One or more spacers may be equipped with sensors which detect the compression force and/or contact point between the spacing element and the adjacent pipe end ,
25 which sensors are coupled to a welding control assembly which controls pipe gripping equipment such that the pipe ends are well aligned and are not tilted relative to each other during the heat up and the subsequent forge welding phase.

30 Description of a preferred embodiment

A preferred embodiment of the method according to the present invention will be described in more detail and by

way of example with reference to the accompanying drawings, in which

Fig.1 depicts a longitudinal sectional view of a forge welding assembly comprising spacer elements for use in the method according to the invention; and

Fig.2 depicts a cross-sectional view of the forge welding assembly shown in Fig.1.

Referring to Figures 1 and 2 there is shown a forge welding assembly in which a set of two or more electrodes 1 transmit high frequency electrical current through the walls of a pair of pipes 2 which are held at a predetermined spacing by a set of four spacing elements 3. The spacing elements 4 are secured to the electrodes 1 by pivots 4 and each spacing element 3 comprises a heat resistant electrically insulating head 3A, which is suitably made of a ceramic material.

The spacing elements 3 may be provided with pyrometric and/or compression sensitive sensors which are able to detect the temperature of the end face of the pipe end during the heat up phase and also the location of the pipe end relative to the spacing element 3 and the compressive force applied by the pipe ends to the spacing element 3. The compression sensitive sensors may comprise piezoelectric elements which are located close to the pipe ends or at a selected distance there from such that the time difference between the transmitted and reflected vibrations is used to assess the contact point(s) and compression forces between the spacing element(s) and the pipe ends.

The sensors may be coupled to a welding control assembly which pulls out the spacing elements 3 from the spacing if the pipe ends have reached a selected temperature which may be below or substantially equal to

the temperature required for forge welding. The spacing elements may furthermore be equipped with channels through which a reducing non-explosive shield gas is injected towards the heated pipe ends. The non explosive shield gas suitably comprises more than 90% by volume of nitrogen and more than 2% by volume of hydrogen.

C L A I M S

1. A method for maintaining a predetermined spacing between pipe ends during a heat up phase before a forge welding operation, the method comprising inserting a plurality of heat resistant spacing elements of a substantially equal thickness between the pipe ends, pressing the pipe ends against the spacing elements during the heat up phase and removing the spacing elements from the spacing before the pipe ends are pressed together to join them by forge welding.
2. The method of claim 1, wherein the pipe ends are heated by electrodes which transmit a high frequency current through the pipe wall to heat the pipe ends and the spacing elements each have a thickness less than 5 millimeters.
3. The method of claim 2, wherein an assembly of three or more spacing elements is inserted between the pipe ends, which spacers each have a thickness less than 2 millimeters.
4. The method of any preceding claim, wherein the spacers are equipped with sensors which detect the temperature, compression force and/or contact point between the spacing element and the adjacent pipe end, which sensors are coupled to a welding control assembly which controls pipe gripping equipment such that the pipe ends are well aligned and are not tilted relative to each other during the heat up and the subsequent forge welding phase and which pulls the spacing elements away of the spacing when the pipe ends have reached a predetermined temperature.

5. The method of any preceding claim, wherein the spacers are equipped with flush gas injection channels which inject a flushing gas around the pipe ends and/or into the pipe interior during the heat up phase.

A B S T R A C T

HEATING CLOSELY SPACED PIPE ENDS BEFORE FORGE WELDING

A method for maintaining a predetermined spacing between pipe ends during a heat up phase before a forge welding operation comprises inserting a plurality of heat resistant spacing elements of a substantially equal thickness between the pipe ends, pressing the pipe ends against the spacing elements during the heat up phase and removing the spacing elements from the spacing before the pipe ends are pressed together to join them by forge welding.

(Fig.1)

figure 2

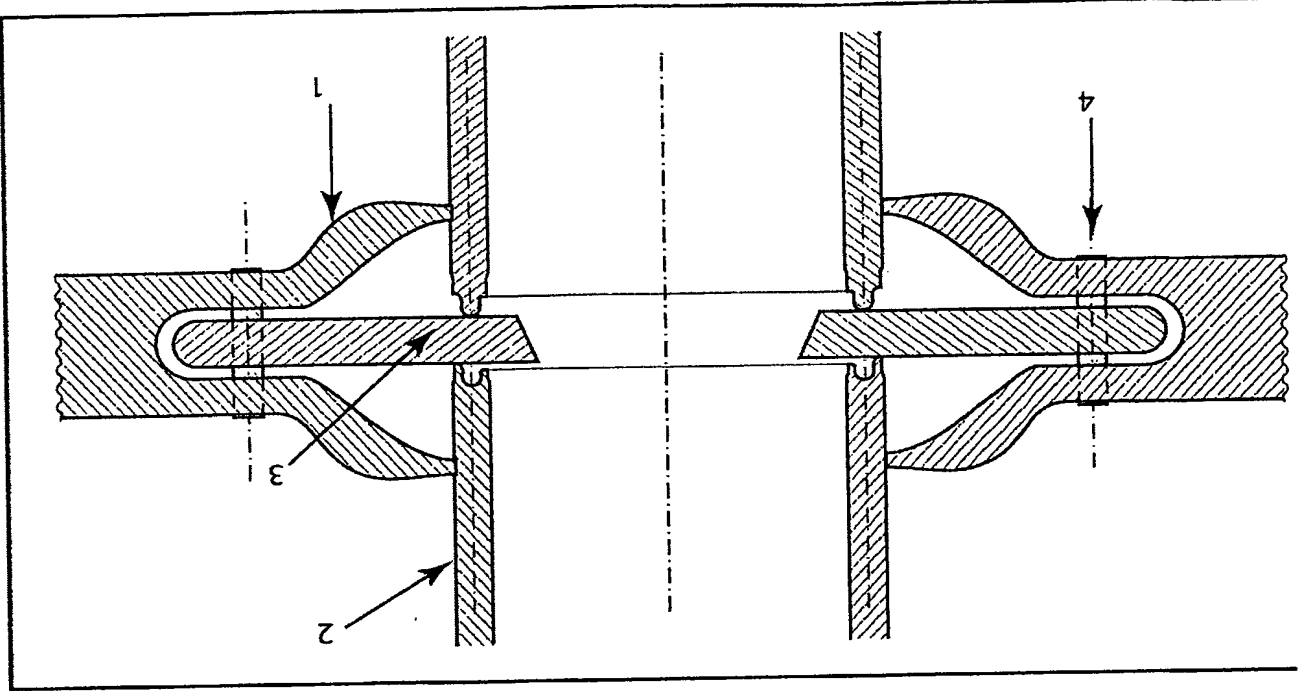


figure 1

